Oceanography B Regional Test

This event covers the fields of physical and geological oceanography.

Resources are limited to a single sheet of paper 8.5x 11 inches and a calculator of any type.

No other student resources are permitted.

The test is 50 minutes in length.

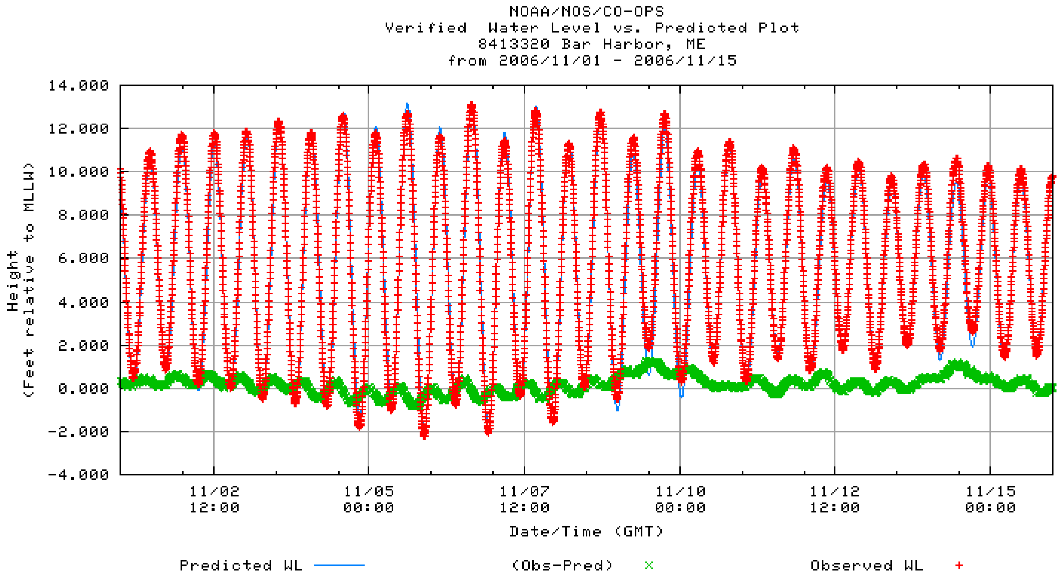
DON'T PANIC!!!

My tests tend to be very hard, with scores ranging from 20-80%.

Good luck!

A. Tides

The following picture shows the predicted water level (relative to mean low tide) at Bar Harbor Maine. The symbols on the curve show the actual water levels, the lower thick line is the difference between the actual water levels and the predictions from a tide model. The horizontal axis shows the time.



1. Identify on the plot examples of high, low, spring, neap, and flood tides. (2 points each) High- any maximum, low- any trough, spring –period of high range (between 11/3 and 11/10) neap-period of low range (11/12-11/16), flood- any rising tide.

2. What are the maximum and minimum tidal *amplitudes* seen during this time period? (5 points)

Maximum range is +13-> -2 =15 ft-> maximum amplitude 7.5 feet
Minimum range is +10->+2 = 8 ft -> minimum amplitude 4 feet
I gave half credit for ranges.

3. What is the dominant tidal component during this time period? How do you know? (5 points)

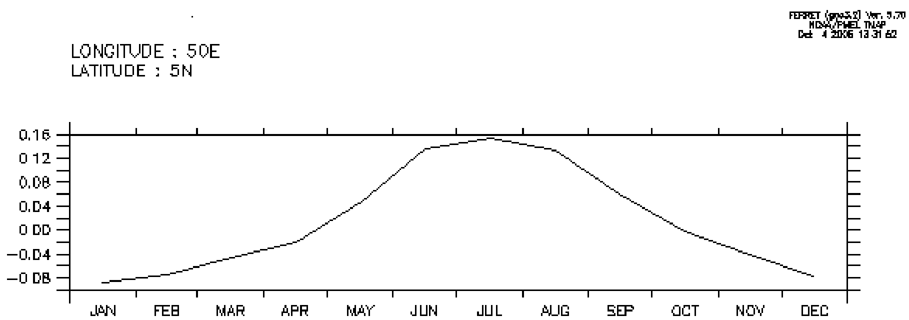
The dominant tidal component is the lunar semidiurnal (M2) tide. You can tell this by counting the number of peaks- from 11/02-11/07 there are 9.5 tidal cycles, implying a period of 12.6 hours. You can also tell because there is a 14-day cycle between maximum range and minimum range.

4. Why does the tidal amplitude change over time? (5 points)

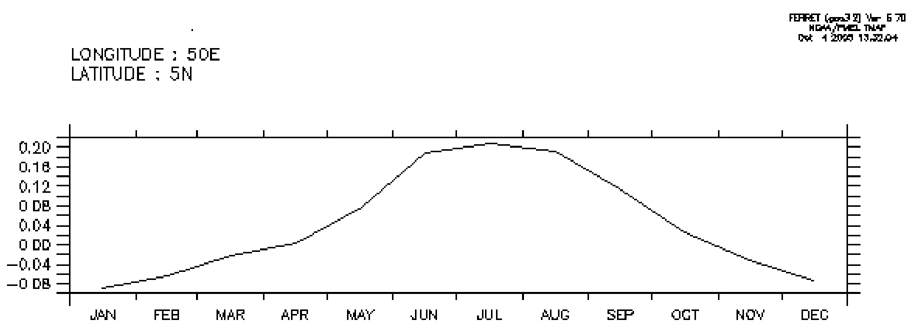
When the moon, earth and sun are in a line the tidal bulges from the moon and sun line up and tidal amplitudes are high (spring tides). When the direction from the earth to the moon is at right angles to the direction to from the earth to the sun, the bulges are not aligned and the semidiurnal tide is minimum (neap).

B. Air-sea fluxes

The questions in this section use the following plot which shows the stress towards the east and north off the coast of Somalia over the course of the year.



Eastward Stress in Pa



Northward Stress in Pa

1. Describe what happens to the winds over the course of the year. (5 points)

In January the winds are blowing towards the southwest and are relatively weak. The winds get weaker towards April, and then start blowing towards the northeast reaching a maximum in the middle of the year (northern summer). The winds then begin to reverse again, reversing direction in late October and then building up to towards the southwest.

2. Explain why the wind direction changes. (10 points)

This is an example of a monsoon circulation. During the northern hemisphere summertime, the sun heats the air atop the Tibetan Plateau more than the air over the Indian Ocean. As a result, the air over the Plateau rises, drawing air from the ocean towards it in a sort of large-scale sea breeze. During the northern hemisphere winter, the air on the top of the plateau cools more than the air over the ocean, and the circulation reverses.

C. Miscellaneous identification (2 points each)

1. Turbidity current: A current that carries large amounts of sediment, often associated with submarine canyons on the continental shelf.

2. Sea stack: A columnar rock feature formed when a wave-eroded sea arch collapses.

3. Chlorinity: The content of all halides in water when (fluorine, iodine,….) are converted to chlorine. OR a quantity proportional to the salinity chlorinity=salinity/1.806. (Half credit for chlorine concentration)

4. Potential density: The density that a parcel of water will have if it is raised to the surface without heat or salt being added or removed from it.

5. Guyot: A flat-topped seamount.

6. Hydrogenic sediment: Sediment generated by chemical processes in seawater (examples would be oolites and manganese nodules).

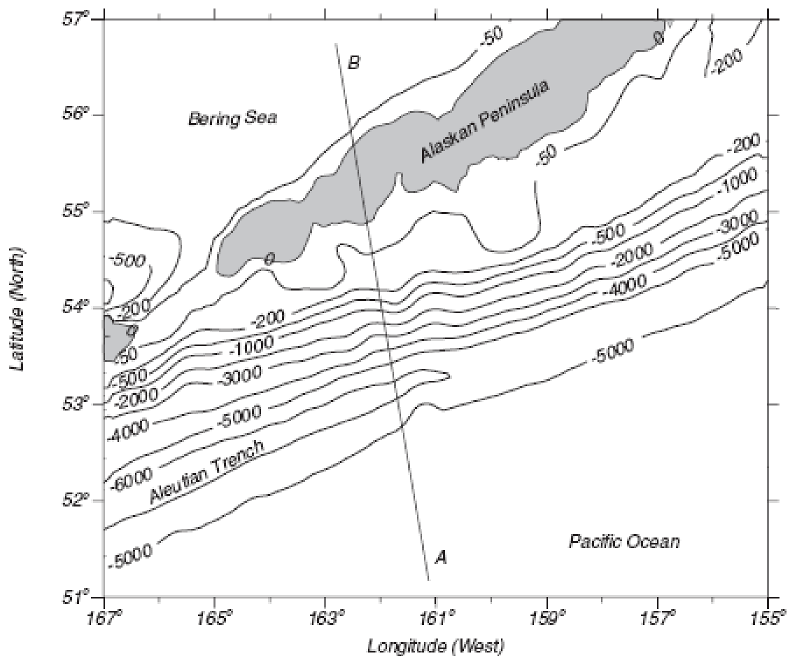
7. Agulhas current: A southward flowing current to the east of South Africa. OR The western boundary current for the Indian Ocean subtropical gyre.

8. Rip current: A strong current flowing *seaward* from the shore (usually generated by localized wave breaking).

9. ARGO float: A free-floating instrument that measures profiles of temperature and salinity.

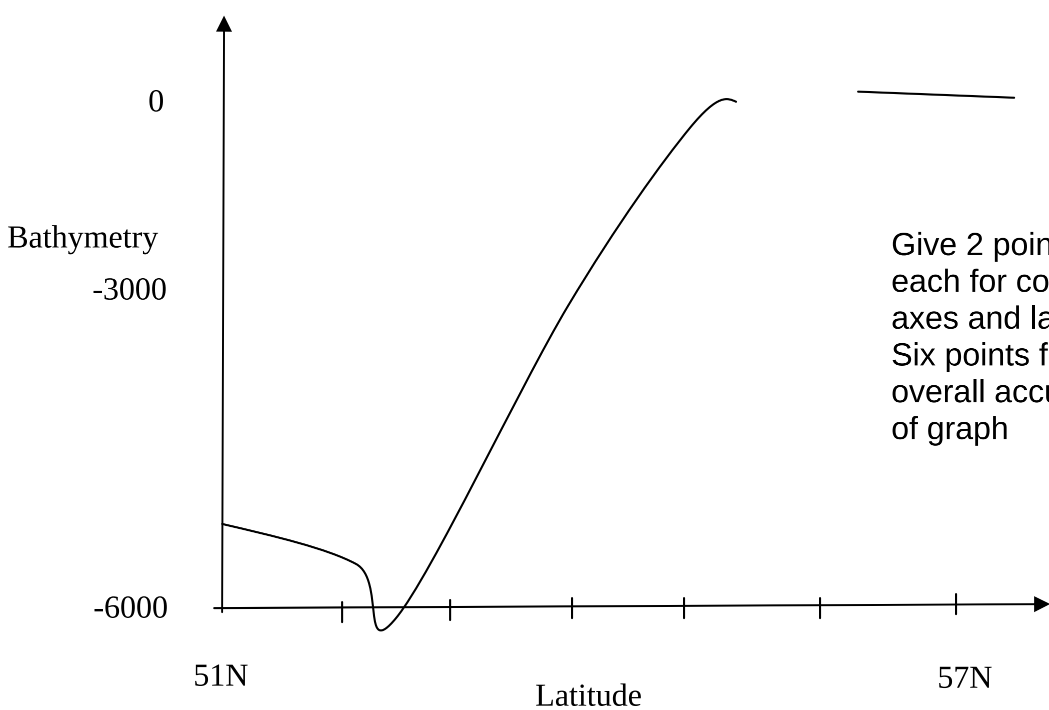
10. Satellite altimeter: An instrument that measures the height of the sea surface. It is used to estimate the depth of the ocean bottom, variability associated with tides and currents, and surface wave height.

D. Ocean topography



The plot above is a contour plot of the bathymetry off of Alaska.

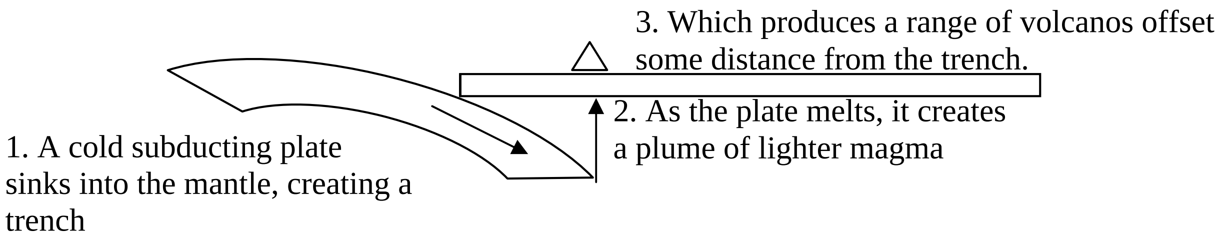
1. Draw and label a plot of the bathymetry vs. longitude along the line AB. (10 points)



Give 2 points each for correct axes and labels. Six points for overall accuracy of graph

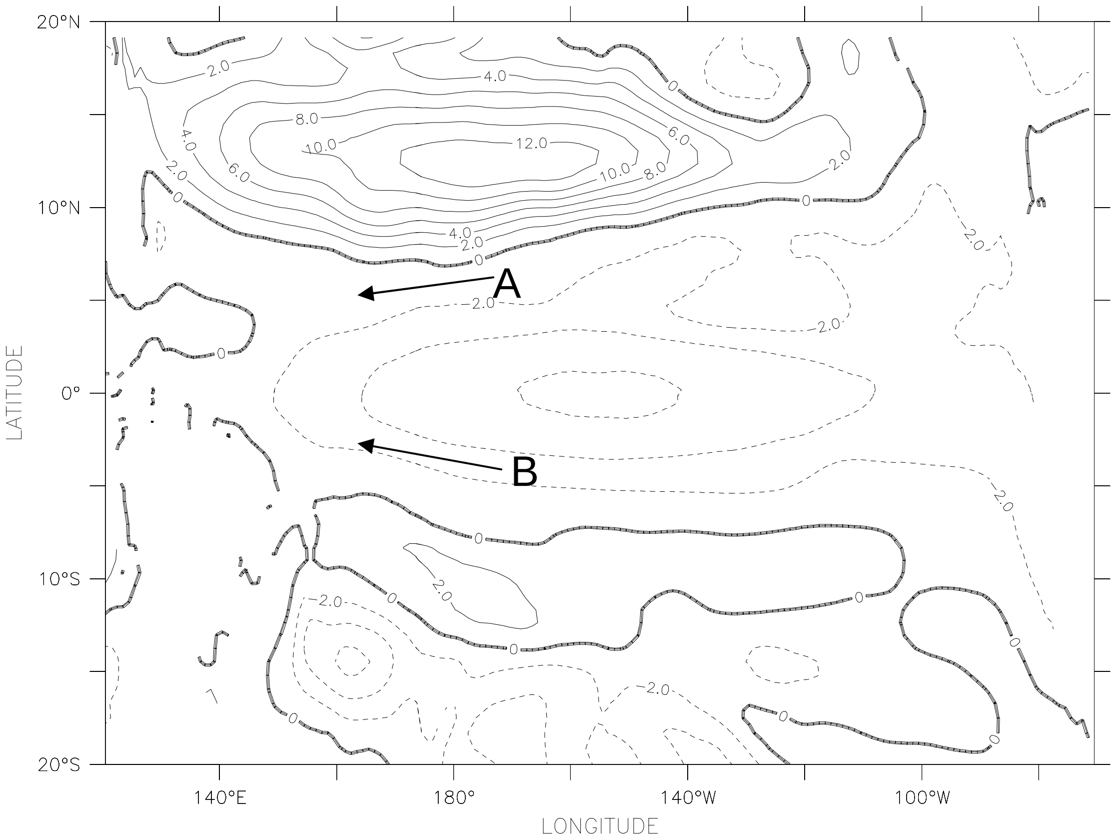
2. This is an example of island arc. How do island arcs form? (10 points)

Island arcs are formed when one oceanic plate subducts beneath another. As the plate sinks it melts, and the lighter magma that results from this melt (often undergoing serpentinization by mixing with water) rises to form a localized hotspot/spreading center underneath the top plate. A schematic is shown below



E. Physical oceanography

The plot below shows an anomaly (deviation from normal conditions) of the sea surface height for a particular period of time over the tropical Pacific Ocean.



Anomalous Sea Surface Height in cm

1. What is going on in this picture? (What phenomenon would cause the sea surface height to be low in this region?). Explain.

This is an example of a La Nina. (5 points) The low pressure in the center of the plot is due to the an upwelling Kelvin Wave (give credit for this answer as well). The sea surface height is lower in the region because temperatures are lower and cooler water takes up less space (it is denser). (5 points) Alternative explanation is that La Ninas are associated with stronger easterly winds over the Pacific that push water away from the equator and create a low.

2. At points A and B draw vectors showing the geostrophic velocity that would be associated with this height anomaly.

(Vectors are drawn on plot. They should be along contours of constant height. If you draw a vector going from high pressure to low pressure, the geostrophic flow is 90 degrees to the right in the northern hemisphere and 90 degrees to the left in the Southern hemisphere).